PB81-246126

Innovative and Alternative Technology Case Studies

Culp, Wesner, Culp-Clean Water Consultants

Prepared for

Environmental Protection Agency
Washington, DC

Jan 81

U.S. Department of Commerce
National Technical Information Service
NTIS.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB81 246126
4. TITLE AND SUBTITLE: Innovative and Alternative Technology - Case Studies		5. REPORT DATE: January 1981 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.: MCD-78
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Same as box 12		10. PROGRAM ELEMENT NO.: 2BG647 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Office of Water Program Operations U.S. Environmental Protection Agency Washington, D.C. 20460		13. TYPE OF REPORT AND PERIOD COVERED: Tech Report 14. SPONSORING AGENCY CODE: EPA-700/02

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report provides case studies of eleven projects which have received additional grant funds through the Innovative and Alterative (I/A) Program.

The purpose of this report is to present information gathered during investigation of eleven case studies. The case study reports describe the project, the I/A components of the project, benefits and impacts of the I/A technology, and in some cases the procedure followed for obtaining grant funding.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Water Pollution Control	Innovative and Alternative Technology	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*: Unclassified	21. NO. OF PAGES: 41
	20. SECURITY CLASS *(This page)*: Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

PB81-246126

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

MCD-78

INNOVATIVE/ALTERNATIVE TECHNOLOGY PROGRAM

CASE STUDIES

BY

DANIEL J. HINRICHS

NANCY E. HEIM

JUSTINE A. FAISST

BRUCE E. BURRIS

CULP/WESNER/CULP

CLEAN WATER CONSULTANTS

JANUARY, 1981

PREPARED FOR

ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF WATER AND WASTE MANAGEMENT

WASHINGTON, D.C. 20460

TABLE OF CONTENTS

Subject	Pages
ACKNOWLEDGEMENTS	ii
CONVERSION TABLE	iv
INTRODUCTION	1
KALAMAZOO, MICHIGAN	3
BURLEY, IDAHO	9
LACKAWANNA, NEW YORK	13
HILLSBOROUGH, NEW HAMPSHIRE	16
REEDLEY, CALIFORNIA	19
MANILA, CALIFORNIA	22
CLEVELAND, MISSISSIPPI	25
JONESVILLE/JERUSALEM, MARYLAND	27
AUSTIN, TEXAS	31
MIRANDA, CALIFORNIA	35
BAY PARK, NASSAU COUNTY, NEW YORK	38
CONCLUSIONS	42

ACKNOWLEDGEMENTS

This report was prepared under the direction of Mr. Lam Lim, U.S. Environmental Protection Agency by Daniel J. Hinrichs, Nancy E. Heim, Justine A. Faisst, and Bruce E. Burris of Culp/Wesner/Culp.

Recognition also is due to the following individuals for their time and assistance in providing information gathered in the case studies:

Orlin Loen	City of Kalamazoo, Michigan
Felix Sampayo	Jones & Henry Engineers, Ltd.
Dail Hollopeter	Jones & Henry Engineers, Ltd.
Brian Myers	State of Michigan
James Bredin	State of Michigan
Robert Martin	City of Burley, Idaho
Bruce Johnson	CH_2M Hill, Inc.
L. Sheldon Barker	CH_2M Hill, Inc.
Basil Tupyi	State of Idaho
Ted Pieczonka	City of Lackawanna, New York
Siegfried Barbasch	Nussbaumer & Clarke, Inc.
Joseph Tuttle	State of New York
Robert J. Johnson	City of Hillsborough, New Hampshire
Ed Rushbrook	Anderson-Nichols & Co., Inc.
James Gill	State of New Hampshire
Robert Cruess	State of New Hampshire
Lary Rihls	City of Reedley, California
Cordell E. Johnson	John Carollo Engineers
Evelyn Tipton	State of California
Virgil McNuth	Manila Community Services District
Dave Tolloson	Winzler & Kelly, Consulting Engineers
Gil Wheeler	State of California
Lavell Hendrix	City of Cleveland, Mississippi
Berry Henson	Clark Dietz Engineers, Inc.
Mark Smith	State of Mississippi
Steve Belanger	State of Mississippi
Eric Larson	Montgomery County, Maryland
Ken Hosto	Kamber Engineering, Inc.
Jean Walbrecker	Kamber Engineering, Inc.
John Milnor	State of Maryland
Sam Warrington	City of Austin, Texas
Chester Green	Parkhill, Smith & Cooper, Inc.
Milton Rose	State of Texas

Bert Stevens	Miranda Community Services District
Marilyn Miller	Winzler & Kelly, Consulting Engineers
Steven Fangmann	Nassau County, New York
Raymond Avendt	Consoer Townsend & Associates, Ltd.

CONVERSION TABLE

1 l/sec (liter/second)	= 0.023 mgd (million gallon/day)
1 kg (kilogram)	= 2.21 lb (pound)
1 joule	= 0.009 Btu (British thermal unit)
1 ha (hectare)	= 2.47 acre
1 m (meter)	= 3.28 ft (feet)
1 km (kilometer)	= 0.621 mi (mile)
1 cm/ha (centimeter/hectare)	= 0.16 in./acre (inch/acre)

INTRODUCTION

This report provides case studies of eleven projects which have received additional grant funds through the I/A Program.

I/A PROGRAM

The Clean Water Act of 1977 was passed by Congress to amend the 1972 Federal Water Pollution Control Act. The original act provided financial assistance to communities for the design and construction of new and improved wastewater treatment facilities. One congressional concern was that there has been little effort to recycle nutrients or treated wastewater, or to eliminate the discharge of pollutants. There has also been concern about the lack of new technology development. Provisions within the 1977 Act are intended to encourage the advancement of technology and resource recovery by increasing grants for innovative and alternative projects. Innovative projects consist of processes or systems which are new technology and include those in which nutrients or water is recycled, energy is recovered, or special sewer systems for small communities are provided. Alternative projects involve land treatment of wastewater or sludge.

The EPA has been delegated the responsibility of implementing the new law and has initiated the I/A Technology Program. This program has been in effect since October 1, 1978. Because of the importance and potential impact of the three-year program, it was determined that the program be closely monitored and evaluated each year.

CASE STUDIES

The purpose of this report is to present information gathered during investigation of eleven case studies. The case study reports describe the project, the I/A components of the project, benefits and impacts of the I/A technology, and in some cases the procedure followed for obtaining grant funding.

There were several factors considered in selecting the projects for case studies. Only approved projects were considered since these same projects could be reviewed again in subsequent years. A variety of projects were selected to give a cross section of various types of systems being classified as either innovative or alternative. Projects from various parts of the country were chosen to illustrate the differences in program administration among the regions. Some of the projects are in delegated states while others are in non-delegated states.

The information for the case studies was obtained through interviews with the various individuals involved in each project and by reviewing project documents. The case studies are primarily for Step 2 grants, therefore actual site visits were not necessary for this initial review. As projects progress through Step 3 and become operational, actual site visits will become more important.

The case study reports cover the following projects:

Innovative Technology

- Kalamazoo, Michigan - Powdered Activated Carbon with Zimpro Reactivation
- Burley, Idaho - Microstrainers to Remove Algae from Stabilization Pond Effluent
- Lackawanna, New York - Aerobic-Anaerobic Dual Digestion System
- Hillsborough, New Hampshire - Application of Rotating Biological Contractors and Solar Heated Anaerobic Digestion with Methane Gas Recovery

Alternative Technology

- Reedley, California - Overloaded Rapid Infiltration Modification
- Manila, California - Pressure Sewers and Community Leachfield
- Cleveland, Mississippi - Land Treatment using Overland Flow

Innovative/Alternative Technology

- Jonesville/Jerusalem, Maryland - Pressure Sewers and Land Treatment
- Austin, Texas - Sludge Digestion using Earthworms to Make Compost, Anaerobic Digestion with Energy Recovery, and Water Hyacinth Ponds with Greenhouse Covers to Treat Sludge Pond Effluent
- Miranda, California - Small Diameter Gravity Sewers and Recirculating Sand Filters
- Bay Park, Nassau County, New York - Fluidized Bed Secondary Treatment System, Anaerobic Digestion with Gas Recovery, and Composting Facilities

KALAMAZOO, MICHIGAN

The existing treatment plant for the City of Kalamazoo does not have adequate capacity to handle the projected loads. Substantial upgrading of the facilities is required. Approximately 5.4 mgd of wastewater are expected to require treatment by the year 2000. The waste will consist of approximately 15 mgd of paper mill flows and 39 mgd of domestic, commercial, and other industrial wastes. The total design loading to the plant will average 60 tons of suspended solids and 80 tons of BOD per day. The proposed plan is to centralize wastewater treatment facilities at the site of the present City of Kalamazoo treatment plant, which will eventually receive flows from a number of other nearby cities and communities.

PROJECT DESCRIPTION

Under the recommended plan, the existing activated sludge wastewater treatment plant will be upgraded to provide the degree of treatment required to maintain water quality in the Kalamazoo River when effluent is discharged to the river. Conventional degritting, comminution, and primary sedimentation precedes the secondary treatment process. The existing facilities will be used to coagulate and settle paper mill wastes, while new primary facilities will be provided to treat the discharge from the municipal sewer system. These primary effluents then will be mixed prior to discharge to the single-stage biophysical system.

In the single-stage biophysical system, the primary effluents will enter a scrubbing channel where virgin powdered activated carbon, regenerated carbon, and return sludge will be introduced. The mixture will then enter conventional aeration tanks. After aeration, a polyelectrolyte will be added and the mixture allowed to settle in the secondary clarifiers, the overflow from which will be filtered, disinfected, and discharged.

Secondary clarifier underflow is returned to the scrubbing channel or wasted to gravity thickeners. The underflow from the thickeners will be pumped to intermediate pressure, wet-air oxidation units where organics will be oxidized and the spent powdered carbon regenerated.

The sludges resulting from primary treatment will continue to be treated using the existing gravity thickening, heat conditioning, vacuum filtration, and incineration equipment.

Innovative Technology

Specific unit processes which qualified as innovative parts of the powdered activated carbon/activated sludge treatment system include:

- Powdered activated carbon storage and application
- Pumping within the powdered activated carbon/activated sludge system
- Spent carbon gravity thickeners
- Spent carbon regeneration (wet-air oxidation unit)

- Gravity separation of carbon from blowdown of regeneration units
- Odor control system utilizing the powdered activated carbon

Impacts of the Project

The following beneficial impacts were among those noted for the proposed project:

- Environmental

  - Water quality in the receiving stream will be improved through the reduction in pollutional discharges to the Kalamazoo River. The process will substantially reduce the discharge of complex organics such as pesticides and herbicides.

  - The diversity of the fish population in the river will be enhanced greatly by providing an aquatic environment that would support intolerant, warm water species. The removal of trace organic compounds could have an additional beneficial effect.

  - Treatment is such that minimum chlorine dosage for disinfection will be necessary, thereby reducing the adverse impacts on fish in the river.

  - Through improvements to the water pollution control practices in the area, the surface water quality would be enhanced. The presence of foam downstream from the plant outfall would be minimized or eliminated entirely, and dissolved oxygen in the river would be improved.

  - Activated carbon will remove the high molecular weight organics produced by the two chemical companies and the pharmaceutical company in the area.

  - There will be a reduction or elimination of odors presently arising from the aeration facilities. Since the powdered carbon in the aeration tanks would adsorb odors, the gases resulting from sludge processing would be deodorized.

  - Less sludge would be burned than at the present time, and facilities to enhance treatment of the flue gases would be added.

  - The project would reduce aerosol production at the plant since the aeration tanks would be partially covered.

- Social

  - Manufacturing and business opportunities in the area may increase as outside industries and businesses continue to develop and expand and require community locations that can provide adequate waste collection and treatment.

  - Several local industries are considering reuse of the treatment plant effluent due to its expected high quality.

- The success of the proposed technology could encourage other communities with similar waste problems to use this same technology.

- Economics

  - More money in grants (extra 10 percent) available to the City and reduced cost to the community (although this was not originally considered when the design was first conceived).

  - The State will benefit in future years if the entire innovative set-aside is used now since reallocation of future grant funds depends on the current use of set-aside money.

  - The project cost is estimated to be about $65,000,000 while the annual operation and maintenance cost is about $4,567,100. The equivalent annual cost of this proposed alternative is about $9,334,714, and is the most economical alternative evaluated in the facilities plan.

The most significant long-term, adverse effects noted in the facilities plan were the possibility of unsightly conditions at the plant in the event of carbon spills during unloading or storage of the powdered activated carbon and substantial increases in energy requirements that would result from implementation of the project.

FACILITY PLANNING EFFORT

Because the facilities plan for Kalamazoo was completed in June 1977, prior to the initiation of the I/A Program, the application process for I/A funding for the City required additional efforts by the design engineers and the City. Specific steps taken in applying for the extra 10 percent included the following:

- A letter was written for the City to the State Department of Natural Resources (DNR) providing the information required in Appendix E of the I/A regulations to qualify the project as innovative.

- The City applied for a Step 3 grant to construct the powdered activated carbon regeneration facilities and secondary sludge handling facilities and to purchase laboratory and maintenance equipment (Contract 39).

- A meeting was held with the DNR to provide information on specific facilities which were being considered innovative.

- The State evaluated the proposed processes and recommended to EPA those processes which the State considered innovative.

- EPA began to question the alternatives comparison used to qualify the project as I/A, and required a special comparison to a conventional alternative not previously addressed by the design engineers.

- State approval of Contract 39 was forwarded to EPA.

- Additional questions were asked by EPA which required a detailed cost breakdown of each I/A component.

- Verbal approval of Contract 39 by EPA was received.

The procedures to obtain I/A funding for the City required considerably more time and money than normally required for conventional grants. Because the facilities plan was prepared before the I/A regulations, much additional supporting material was requi.ed above and beyond that contained in the facilities plan. The application process was further complicated by reviews needed for AWT facilities approval, and because the contract was sole source (Zimpro).

Project Alternatives

The following seven alternatives for water pollution control were considered in the facility plan:

- No Action - was not considered to be viable since it would not restore the physical, chemical, or biological integrity of the Kalamazoo River.

- Low Flow Augmentation - was eliminated from consideration due to high financial and environmental costs. This alternative would require large amounts of land, alter ecological balance in storage areas, and require relocation of a large number of families.

- Plant Effluent Storage - was considered and discarded due to high financial and environmental costs as well as low social acceptability.

- Stream Aeration - was not considered to be feasible due to technological considerations, adverse environment impact, and poor implementability.

- Treatment and Discharge - from a regional wastewater treatment facility received detailed consideration since it would produce the necessary plant effluent without having significant negative environmental impact. Several treatment schemes were investigated under this alternative including:

  - Single-stage carbonaceous and nitrogenous BOD removal using a biophysical process (recommended plan).

  - Two-stage carbonaceous and nitrogenous BOD removal using activated sludge with high purity oxygen in the first stage and biophysical process in the second stage.

- Land Application - was eliminated in the final screening process due to its high financial and environmental costs. This alternative would also require the relocation of many families.

- Treatment and Reuse - facilities could be added in the future since the potential for reuse would not alter significantly the present design requirements.

Selection Procedure

The rationale in selecting an innovative process for the City of Kalamazoo was somewhat unique; the planning effort began in 1973, several years before the I/A program was initiated. Extensive pilot tests showed that conventional treatment schemes were inadequate due to the nature of the industrial wastes to be treated. The proposed innovative process was selected (independent of the I/A program) because it was the only system tested which consistently produced reliable results that were not susceptible to upsets, and the most cost-effective alternative evaluated. In short, the selected process was the "Best Technology" to treat the waste.

Because the facilities plan for Kalamazoo was prepared prior to the initiation of the I/A program, the original planning effort did not consider any conventional treatment processes in great detail. However, in applying later for grants through the I/A program, the designers were required to evaluate and compare the innovative process with the best conventional process. Consequently, a conventional two-stage AWT plant was used for the comparison.

Qualification of the I/A Project

The following summarizes the criteria used to qualify the plant for an innovative technology grant:

- Life Cycle Cost - The life cycle cost for the conventional two-stage AWT plant is $141,396,319. The selected innovative biophysical plant has a life cycle cost of $118,609,173. This represents a cost savings of $22,787,000 or 16.1 percent which qualifies the project under the 15 percent life cycle cost reduction criteria.

- Net Primary Energy Requirements - The operation and maintenance of the biophysical system will result in an average daily use of 6.5×10^9 Btu. The net primary energy requirements of the selected process are 78 percent of those for the next most cost-effective project which would require 8.4×10^9 Btu. The selected process qualifies as innovative on the basis of net primary energy requirements.

- Operational Reliability - Many treatment processes were pilot and/or bench tested in facilities planning. The only process that produced reliable results, was not susceptible to upsets of interference, and adequately treated the wastewater was the biophysical system. A computer will be installed to optimize treatment performance and to minimize the level of operator attention and skill required. Thus, the selected process meets all the criteria used to designate innovative processes and techniques.

- Management of Toxic Materials - The activated carbon used in the biophysical process effectively removes a long list of toxic, potentially toxic, and other materials thus providing better management of toxic materials than any of the other treatment processes investigated in facilities planning. The selected process qualifies as innovative by providing excellent management of toxic materials that would otherwise result in environmental hazards.

- Increased Environmental Benefits - The treatment works will produce a high quality effluent that can be reused by industries. Reuse of plant effluent by industry would result in substantial water conservation. Local industries have been made aware that large quantities of high quality effluent will be available upon completion of the project. Several high volume users are located near the treatment plant.

  The selected project uses less land than any other alternatives considered in facilities planning. Thus, the land is used more effectively.

  The selected project will improve air quality over present conditions by controlling odors. The particulates discharged to the atmosphere will be reduced from those produced by the other alternatives since only the primary sludge will be incinerated.

  Improved groundwater conditions will result if industries reuse the plant effluent. Some of the potential industrial users could discontinue pumping groundwater, thus increasing the volume of this resource.

  The selected process will result in substantial reduction in construction costs over the other projects evaluated in facilities planning. The estimated total cost of the selected project is $65,000,000. The cost of the two-stage system is $76,847,600. The cost of the land application project is $99,269,700.

- Improved Methods of Joint Treatment/Management - The facilities will be designed to treat approximately 54 mgd. The project provides an excellent method of joint treatment/management by concentrating at one location the treatment of diverse, difficult to treat industrial wastes. Using municipal and pharmaceutical wastewaters to provide nutrients for the treatment of paper mill wastes is an improved method of joint treatment/management.

BURLEY, IDAHO

The City of Burley, located in southern Idaho along the Snake River, operates an aerated lagoon and stabilization pond treatment facility. The original stabilization pond facilities were constructed in 1962 and consist of a 6-ac primary cell and a 7.2-ac secondary cell. In 1979, construction was completed on an additional aerated lagoon to precede the ponds, and effluent chlorination. In the spring of 1980, construction will begin on an algae removal process that will allow the plant to meet secondary treatment requirements. The design flow for Burley is 2.3 mgd. The average flow treated in 1977 was about 1.6 mgd and the flow is projected to reach 2 mgd by 1990.

PROJECT DESCRIPTION

The proposed project is designed to remove algae from the effluent of the aerated lagoon/stabilization pond facility by using microstrainers. During the summer and early fall months, excess algae in the effluent have in the past caused difficulty in meeting the 30 mg/L concentrations for BOD and suspended solids required by the NPDES permit.

Innovative Technology

The proposed facilities include the innovative use of microstrainers to remove algae from the stabilization pond effluent. In the past, the pore size available in the strainer material used in microstrainers was too large to remove algae from wastewater. However, there is now some evidence that a new strainer material with a one-micron pore size can effectively remove algae from wastewater. As a result of successful pilot tests, this type of microstrainer will be incorporated in the Burley facilities.

The pilot tests using microstrainers showed suspended solids removal by passing wastewater through a strainer cloth which retained solids larger than one-micron. A continuous, pressurized backwash spray of effluent cleaned the strainer cloth. In the full-scale microstraining facility, the concentrated solids in the backwash water will be recycled to the primary cell of the stabilization pond system.

Impacts of the Project

If the microstrainer system works as planned, the following beneficial impacts may result:

- The City should be able to meet the BOD and suspended solids concentrations in the NPDES permit.
- Cold water fisheries in the Snake River would improve due to a decreased dissolved oxygen demand.

- The effluent discharged to the river would have less green color.

- Operation and maintenance cost to the City (and resulting user charges to residents) would be lower than if the non-innovative chemical precipitation alternative were used.

- The City could benefit from good advertising. Numerous calls and letters have been received at the City, even before start of construction.

FACILITY PLANNING EFFORT

The original wastewater facility plan for Burley was completed in June 1976. The plan recommended that lagoon improvements be designed and constructed in two separate phases. The Phase I improvements, involving design and construction of an aerated pond to precede two exising stabilization ponds and a chlorine contact chamber, have been completed and are currently in operation. The Phase II improvements involve the design and construction of an algae removal process capable of meeting secondary treatment standards. The original facility plan addressed several methods of algae removal including chemical treatment with clarification or dissolved air flotation, mixed media filtration, intermittent sand filtration, submerged rock filters, microstraining, and phase isolation. The Phase I and Phase II improvements were separated to allow additional time for evaluation of a new technique of lagoon operation called phase isolation.

An addendum to the facility plan dated May 1977 evaluated three alternatives for algae removal: phase isolation, intermittent sand filtration, and chemical treatment with dissolved air flotation and mixed media filtration. The recommended alternative in the addendum was the chemical treatment alternative primarily because of reliability considerations. However, the Water and Sewer Superintendent for the City of Burley was opposed to the recommended chemical treatment alternative due to the high operating costs. At this time, the project was delayed while alternatives to chemical treatment were considered.

Following the development of improved microstrainer technology in the form of a one-micron pore size screen, an economic comparison with the previous cost-effective alternative was warranted. However, the State of Idaho and EPA wanted verification that the microstrainer project could work. In the fall of 1978, microscreen field tests were conducted at the Burley lagoons. An aquaculture system utilizing several species of fish in the stabilization pond to consume algae was evaluated in combination with microscreens. Wastewater Facilities Plan Addendum No. 2, dated January 1979, summarized the results of the field tests. Also reported were the results of other microstraining projects and an economic comparison of microstraining-aquaculture treatment vs. chemical treatment with filtration. Addendum No. 2 recommended using a combined microstraining-aquaculture algae removal system and applying for I/A funding.

Project Alternatives

Alternatives considered during various stages of project planning include:

- Chemical treatment with clarification or dissolved air flotation
- Mixed media filtration
- Intermittent sand filtration
- Submerged rock filters
- Microstraining
- Phase isolation

The final comparison of alternatives made in Addendum No. 2 compared only the following alternatives:

- Chemical treatment with dissolved air flotation and mixed media filtration
- Microscreening in combination with aquaculture.

Selection Procedure

An economic comparison of the microstrainer-aquaculture treatment system with the previous cost-effective alternative, chemical treatment with filtration, was made in Addendum No. 2. The microstrainer-aquaculture treatment was found to be 28 percent less costly on a present-worth basis than chemical treatment with filtration. An added benefit was a 25 percent savings in primary energy. Based on the cost and energy savings, it was recommended in Addendum No. 2 that the City of Burley apply for an innovative technology grant from EPA and Idaho Department of Health and Welfare for the design and construction of a full-scale microstrainer-aquaculture treatment system. These facilities would be included as part of the City's Phase II treatment improvements.

With proper operation, both the City and the State felt there was little risk associated with the microstrainer alternative; the consultant and the City also said these processes would have been selected even without the I/A program or its funding.

Qualification of the I/A Project

The microstrainer portion of the microstrainer-aquaculture alternative was considered innovative by both the State and EPA following submittal of Addendum No. 2 which presented results of the field tests. The microstrainer project was less costly, required less energy, and was considered innovative because similar applications of the equipment were rare. Overall, the performance of the microstrainer was encouraging. However, it was impossible to conclude with certainty whether large concentrations of single-cell algae could be removed from the pond effluent by microstraining. The EPA Region X coordinator for the I/A program concurred in this opinion following discussion with EPA Headquarter's personnel.

The aquaculture system was rejected by the State and EPA as being both unproven and unnecessary. The regulatory agencies recommended that the microstrainer be used alone for at least two or three seasons and that growth control processes (including aquaculture) be reconsidered after evaluation of operating data for that period.

LACKAWANNA, NEW YORK

The City of Lackawanna, on the southwestern border of Buffalo, New York, operates a wastewater treatment plant consisting of primary clarification, anaerobic digestion, and sand drying beds. The nominal capacity is .53 mgd and the effluent is discharged to Class D Smokes Creek which feeds into Lake Erie. The City is under long-standing orders to upgrade the plant to secondary treatment and include phosphorus removal.

PROJECT DESCRIPTION

The sewage treatment plant for the City of Lackawanna is designed as a pure oxygen activated sludge plant. The project consists of upgrading a primary facility to secondary treatment on an existing limited site. The sludge digestion facilities already exist and need only upgrading for high-rate digestion. The existing digesters will be converted to a dual-digestion system which combines both aerobic and anaerobic sewage digestion processes. The process is designed for one-day detention in the aerobic digester followed by 8 days detention in the anaerobic digester.

Innovative Technology

The sludge digestion system being designed for the City is considered innovative/alternative technology (not yet designated; EPA calls it alternative, the designer calls it innovative). The proposed sludge treatment is a proprietary process and is described as a Dual Digestion Aerobic-Anaerobic Sludge Digestion Process (DDS). The system basically consists of a small digester being fed with pure oxygen and being operated at a temperature sufficiently high to generate enough heat to achieve thermophilic conditions in the anaerobic digester. The anaerobic digester is mixed, but not heated. Due to the heat generated in the aerobic digester, the operating temperature will be maintained at approximately 50°C.

The project also includes digester gas recovery to be used for a combination of in-plant heat and direct-drive power generation. This system was selected because it provides the following advantages:

- In-plant heat generation is the most energy efficient utilization because it avoids multiple conversions of energy;
- Direct-drive is more efficient than conversion to electrical power; and
- Under the given conditions, heat generation and direct-drive require the least auxiliary, mechanical, and electrical equipment.
- The combined system will allow for 90 percent gas utilization which is necessary to qualify for I/A funding.

Impacts of the Project

Impacts associated with the proposed technology of the project include:

- Marginal cost-effectiveness, achieved primarily because the digesters were already existing at the plant, and an inexpensive source of oxygen was available.
- Energy generation by the DDS process in the form of digester gas
- DDS process requires more labor to control aerobic digestion and digester gas power generation (two unit processes).
- No chemicals are required and the process is more stable than conventional digestion.
- Higher capital cost (specific to this project site only), but lower O&M costs. This is due to the absence of boilers and heat exchangers, and elimination of heating costs for the anaerobic digester.
- Increased reliability.

FACILITY PLANNING EFFORT

The original facilities planning effort for upgrading the plant began in 1975 when construction of an activated sludge facility with alum addition, filtration, and an increase in anaerobic digestion capacity was proposed. In 1977, final plans for upgrading the facility were initiated, and the use of pure oxygen aeration was determined to be cost-effective. In July 1978, Union Carbide approached the designer with its proprietary DDS process as an alternative to conventional anaerobic digestion. As a result of the I/A program incentives, the consultant investigated the feasibility of utilizing the process and qualifying for I/A funding.

Project Alternatives

Alternatives considered during various stages of project planning included:

- Conventional activated sludge with filtration and phosphorus removal followed by anaerobic digestion.
- Pure oxygen aeration followed by filtration, phosphorus removal, and anaerobic digestion.
- Dual (aerobic-anaerobic) digestion vs. conventional anaerobic digestion.

Selection Procedure

The financial incentives of the I/A program and professional challenge to the consulting engineer played an important role in the selection of the proposed

technology. The energy production and overall increased reliability due to fewer operational problems with the DDS process also were important.

Qualification of the I/A Project

The regulations specifically list anaerobic digestion with 90 percent gas utilization as alternative technology. This particular application, however, starts from a process which has only been demonstrated in a pilot plant. Consequently, because it has not been proven on a large scale, the consultant believes it should qualify as innovative technology. The project also qualifies as innovative under the criteria of "increased reliability".

HILLSBOROUGH, NEW HAMPSHIRE

The Town of Hillsborough, located about 35 miles southwest of Concord, New Hampshire, has no treatment facility and currently discharges raw wastewater into the Contoocook River. The existing town population of 2,050 produces a wastewater flow of 322,000 gpd.

PROJECT DESCRIPTION

The proposed project consists of constructing a new wastewater treatment facility with rotating biological contactors (RBCs) and sludge treatment with anaerobic digestion. The project includes solar heating of the digesters and buildings, digester gas use to generate electricity, and heat recovery from the gas engines. The average design flow rate is .46 mgd, with a projected peak flow rate of 2 mgd.

Innovative Technology

The innovative technology components include the primary clarifiers, RBCs, anaerobic digesters, power generation and heat recovery, and solar heating.

The methane gas available from anaerobic digestion will power electrical generation equipment on a regular and emergency basis. Solar heating will provide 75 percent of the anaerobic digester heat requirement and of the overall space heating requirement. Heat recovery from the internal combustion engine used to generate electricity will provide a portion of the remaining space heating requirement. Heat will also be available from heat pumps in the secondary digester and the wastewater effluent.

Primary clarifiers were selected over screens to improve solids removal from the raw wastewater, thereby maximizing the primary solids delivered to the anaerobic digesters.

Impacts of the Project

If the proposed plant works as planned, the following beneficial impacts will result:

- The last remaining discharge of raw wastewater to the Contoocook River will be eliminated, making the river safe for swimming.
- There will be renewed potential for growth in the town.
- There will be new job opportunities for operators and maintenance personnel at the new water pollution control plant.
- The treatment plant will conserve energy.

FACILITY PLANNING EFFORT

Planning for the water pollution control facilities in Hillsborough began in 1965. The result of the planning effort was the preparation of a Preliminary Report (on Sewerage and Sewage Disposal System in 1967), which proposed sewers and the construction of a wastewater treatment facility. Although plans and specifications were prepared in 1970, the system was not constructed due to a lack of federal funds at that time.

Significant changes in requirements for water pollution control projects were made by the passage of the Federal Pollution Control Act Amendments of 1972 (Public Law 92-500). As a result, a municipal wastewater facilities plan for the Town of Hillsborough was prepared in 1975-76 to update the project. The facilities plan recommended a secondary treatment facility incorporating the extended aeration process.

At the town meeting in Hillsborough in 1977, it was voted that the Town form a Sewer Study Committee to evaluate the annual operational cost and energy requirements of the proposed facilities prior to committing the project to final design. The Committee's purpose was to encourage the consideration of methods of reducing energy requirements and operational costs of the proposed facilities through design modifications and techniques.

As a result of the Committee's initial investigations, it was decided that the first step of the design phase (Step 2) of the project should include an evaluation of modifications of the treatment facility. This evaluation would be aimed at reducing energy requirements, identifying alternative energy sources, and incorporating energy saving design techniques. The evaluation is summarized in "The Report On Energy Conservation and Alternative Energy Sources For Wastewater Treatment Facilities," dated November 1978. In this report, it was recommended that the proposed project be designated as "innovative" under the I/A program.

Project Alternatives

The following three alternatives were evaluated in the November 1978 report on energy conservation:

- Extended aeration wastewater treatment and sludge treatment by aerobic digestion
- Primary screens, RBCs, and aerobic digestion
- Primary clarifiers, RBCs, and anaerobic digestion

The major differences between the wastewater treatment alternatives are that RBC units and primary screens or clarifiers replace the aeration tanks in the extended aeration process. For the sludge treatment scheme, solar heated anaerobic digesters would replace the aerobic digesters. Solar heat to provide space heating and hot water requirements and the use of a heat pump on the effluent were included with all three alternatives.

Selection Procedure

The selection of the proposed project was based primarily on energy savings. The energy cost was determined to be 69 percent less than that for the RBC plant with aerobic digestion and 78 percent less than the extended aeration plant. The total present worth cost of the selected alternative was 14 percent higher than that of the RBC plant with aerobic digestion. Besides energy savings, the proposed RBC plant with anaerobic digestion had the lowest total operation and maintenance cost. The RBC process was considered to have better process stability than extended aeration. The proposed project, including solar heated anaerobic digestion with methane gas recovery, was noted in the project report as leading to the advancement of technology.

Qualification of the I/A Project

The RBC plant with anaerobic digestion was considered innovative by the State primarily because of the large energy savings over the other two alternatives. The EPA made a detailed technical review of the proposed project and anticipated energy savings, and agreed that the project was innovative.

REEDLEY, CALIFORNIA

Reedley, California is a city with a population of about 10,000 people located by the Kings River in the southern portion of the San Joaquin Valley. The City is one of many in this highly productive agricultural area and relies heavily on local food packing and distribution industries. The projected growth of Reedley is substantial, with a 35 percent increase expected in the next 10 years and a 65 percent increase in the next 20 years. The existing wastewater treatment facilities for the City include an Imhoff tank followed by a low-rate trickling filter that dates back to 1924, and a high-rate trickling filter facility built in 1970. These facilities are minimally adequate to meet the current treatment requirements and will not satisfy future requirements.

PROJECT DESCRIPTION

The proposed project is to expand the existing high-rate trickling filter facility with the addition of an oxidation ditch and secondary clarifiers. Effluent disposal will be to percolation-evaporation ponds. A portion of this effluent will be recovered through an underdrain system, chlorinated, and discharged to the Kings River. The chlorinated underdrain effluent will be made available for reuse as irrigation water as the demand warrants.

The construction of the new facilities has been planned in two stages, with an ultimate capacity of 3.68 mgd to serve a year 2000 population equivalent to 16,500. The oldest facilities at the plant (Imhoff tank and slow-rate trickling filter) are to be abandoned, and the capacity of the high-rate trickling filter will be reduced from 0.69 mgd to 0.46 mgd on a maximum month basis.

Alternative Technology

The portion of the proposed project that qualifies as alternative technology is the disposal system. Although the existing treatment plant includes percolation ponds and irrigation fields for effluent disposal, there is insufficient land area near the plant to continue these methods of effluent disposal in the future. A silt layer 3 to 4 feet below the ground surface prohibits deep infiltration into the groundwater, therefore an underdrain system will be used to collect percolate. Recovered effluent will be chlorinated and subsequently discharged to the Kings River or used as an irrigation supply.

It is anticipated that discharge to the River will only be required during the winter months. During the summer, the evapotranspiration potential is very high as are the local irrigation demands.

Impacts of the Project

The beneficial impacts of the proposed project identified in the Draft Environmental Impact Report are summarized below:

- Elimination of present seasonal wastewater facility overloads.
- Permit compliance with proposed new discharge requirements.
- Protection of Kings River waters and local groundwaters against contamination.
- Allowance for continued community growth without the excessive sprawl and agricultural land usage that would be engendered by residential on-site sewage disposal land requirements.
- Allowance for most economical and timely plant expansion with maximum utilization of now-available State and federal funding.

The following adverse impacts also were noted for the proposed project:

- The recommended disposal alternative creates a possible psychological impediment to recreational usage of the Kings River.
- Residential sewer service charges in the community will be increased from $2.00 to $5.60 per month.

FACILITY PLANNING EFFORT

The facility plan for Reedley was initiated in November 1977, prior to passage of the Clean Water Act of 1977. The initial alternative proposed by the City's consultant was to purchase additional land adjacent to the existing treatment facilities so the disposal area could be expanded. This alternative was the least costly, but was considered both environmentally and socially unacceptable. The consultant reassessed the project alternatives in light of the potential benefits offered by the I/A program and amended the project reports accordingly.

Project Alternatives

The initial alternative analysis involved two disposal methods plus several treatment methods appropriate to meet quality requirements for disposal. Methods of waste disposal that were evaluated included:

- Purchasing additional land and continuing the present practices of percolation-evaporation and flood irrigation
- Utilizing the existing disposal area and discharging excess wastewater into the Kings River.

Since different methods of disposal require different levels of treatment, several alternative treatment methods were reviewed. For land disposal only, high-rate trickling filters and oxidation ditch treatment were considered. For the combination of land and river disposal, only extended aeration by an oxidation ditch was considered. However, that portion of the flow to be discharged would receive additional treatment via percolation through at least 6 feet of soil. In either disposal case, the newer of the trickling filter treatment facilities would be kept in operation, while the older facilities would be abandoned.

Selection Procedure

A cost-effectiveness analysis was made on the alternatives considered most feasible from an engineering viewpoint. The analysis included economics as well as environmental and social impacts. Additional factors such as utilization of scarce resources, flexibility and reliabilty, ability to implement, and public acceptability also were considered. The evaluation factors were given a relative weight and the alternatives given a ranking. The alternative with the highest weighted rating was selected as the apparent best alternative project.

The apparent best alternative project involved oxidation ditch treatment and disposal to land with an underdrain collection system to allow river disposal of excess flows. The next highest ranked alternative involved essentially the same method of treatment, but with the purchase of additional land for disposal of plant effluent.

A further step in the alternative analysis was taken in light of the potential for additional grant funds under the I/A program. The apparent best alternative project was compared to alternatives having other methods of disposal. One of these methods involved removing the silt layer and utilizing the existing disposal site for percolation ponds. The other method used conventional advanced wastewater treatment (AWT) with discharge of all wastewater to the Kings River. Several amendments to the project report detailed these alternatives.

Qualification of the I/A Project

According to a report prepared by the consulting engineer in October 1979, the proposed project qualifies for innovative funding under the cost savings and increased environmental benefits criteria. The analysis of costs over and above secondary treatment show that the present worth of the underdrain system alternative is 42 percent less than removing the silt layer, and 67 percent less than AWT and river disposal. Since the basic treatment costs are not included in the analysis, it is impossible to compare the entire system costs with the other alternatives as required by the I/A guidelines.

With regard to the increased environmental benefits criteria, a high quality water will be available to local farmers for use in crop irrigation. It is also possible that there may be a future industrial demand for this water. The soil treated effluent will be available at a depth of approximately 6.5 ft whereas groundwater used for irrigation must be pumped from depths ranging from 25 to 50 ft.

An energy analysis of the three alternatives was not available nor was a chemical use analysis. From the draft project report, the apparent best alternative project required about twice the electrical energy as the least energy alternative over the first 10 years of operation and almost two and one-half times the energy during the second 10 years of operation. This alternative also has a chlorine demand which the initial alternatives did not have. However, the other initial alternatives were environmentally and socially unacceptable since they required the conversion of prime agricultural land to effluent disposal sites.

MANILA, CALIFORNIA

Manila Community Services District (CSD) is a community with about 1,200 residents located on the Pacific Ocean, a few miles from Eureka, California. The area is built on sand dunes and because of its proximity to the Ocean has a high groundwater table. In 1967, a community water supply system was completed, however, waste disposal was provided by individual septic tanks. The septic tanks were frequently subject to failure; even in drought years the failure rate was 33 percent as reported by the county health officials. Although the groundwater is no longer a major source of drinking water, nearby Humboldt Bay is an important resource for the shellfish industry. The quality of the Bay was being jeopardized by contaminated runoff and groundwater outcroppings draining into it.

PROJECT DESCRIPTION

The project implemented for Manila CSD is a pressure sewer system and a leachfield disposal system. As well as being funded by the I/A technology program, this project was designated a demonstration project by the Department of Research and Development of the State Department of Water Resources. As such, 100 percent of the grant eligible capital costs and the O&M costs for the first two years have been paid through various grant funds. This has been a very important factor in the implementation of the project since the area is impoverished and would not have been able to finance even the local share costs.

Construction of the project involved installing water-tight septic tanks for each residence or cluster of residences. Waste flows from the residences to these septic tanks where the solids are separated out and allowed to digest. Effluent from the tanks is pumped to a central point in the system through small diameter pipelines. A commmunity leachfield located in the sand dunes is used to dispose of the effluent. Initially, this was to be an interim measure since a regional treatment facility was being planned and would have sufficient capacity to treat the septic tank effluent from Manila. However, the plans for regionalization have been suspended and the leachfield is to be a permanent facility.

Alternative Technology

Both the collection system and the disposal method are considered alternative technology. The terrain is not suited to gravity collection without the installation of very deep (12 ft) sewers and numerous lift stations. Effluent disposal to the land was originally intended as an interim measure and was less costly than providing treatment (aerated lagoon) and an ocean outfall. The system is functioning well and is acceptable as a long-term disposal method.

Impacts of the Project

Recognized benefits of the proposed project include:

- Most cost-effective alternative

- Minimal visual impact from facilities (the only aboveground facilities are the electrical boxes and pump housing and the central pump station)
- Decreased potential for contaminating ground and surface waters
- Stabilization of sand dunes over leachfield.

Potential adverse impacts of the project include:

- Requires maintenance of numerous types of pump units
- Septic tanks are on private property, but must be serviced by the District.

FACILITY PLANNING EFFORT

The facility planning for Manila was completed prior to the passage of the Clean Water Act of 1977. The project as implemented is little different than that originally recommended with the exception of the change in the status of the leachfield, which is now to be a permanent rather than an interim facility.

Project Alternatives

Originally, five collection alternatives and seven treatment and disposal alternatives were proposed by the consultant. After the initial screening, three collection and four treatment and disposal alternatives were subjected to critical, detailed analysis.

The collection alternatives included a gravity system for raw sewage with five intermediate lift stations, a septic tank effluent pumping (STEP) system with small diameter pressure sewers, and a grinder pump (GP) collection system for raw wastewater.

The treatment and disposal alternatives included a package treatment plant with effluent used for irrigation; an aerated lagoon system, again with irrigation; flow equalization with an interceptor to the proposed regional facility; and an interim lagoon with irrigation of effluent. The leachfield disposal system was investigated after most of the facility planning effort had been completed. It proved to be the most viable, cost-effective interim project.

Selection Procedure

The selection of the apparent best alternative project was based on a matrix analysis. The evaluation criteria included monetary, environmental, and social impacts as well as considerations such as resource utilization, flexibility, reliability, etc. These factors were given weights according to their importance on a local level.

The analysis of alternatives was not influenced by the potential of grant funding beyond the standard 87-1/2 percent normally available for projects in California.

Qualification of the I/A Project

Originally, this project was selected as a demonstration project, thereby qualifying for 100 percent funding of grant eligible capital costs and O&M costs for the first two years of operation. The State later requested that the grantee apply for I/A funding. As an I/A project, any redesign and construction costs would be 100 percent grant eligible should the system fail.

The project qualifies as an alternative project by definition since it involves an alternative collection system for a small community and it provides for land treatment and disposal of effluent.

CLEVELAND, MISSISSIPPI

The initial facility planning efforts for the City of Cleveland began in 1974 and concluded in 1977 with the approval of a 3.0 mgd extended aeration activated sludge treatment facility. Because of local sentiment against the implementation of a mechanical treatment system, the project was delayed to allow reassessment of facility alternatives. In light of the provisions of the Clean Water Act of 1977, reevaluation led to the recommendation of overland flow as the preferred method of wastewater treatment for the community.

PROJECT DESCRIPTION

The project proposed for Cleveland consists of a storage lagoon system adjacent to an overland flow treatment site. Approximately 500 acres (167 ac/mgd) is planned for the spray field, with additional land needed for buffer areas and service access. The runoff will be collected and discharged to local surface waters. It is anticipated that a cover crop will be grown on the site, and then harvested and sold to help defray the cost of system O&M.

Alternative Technology

The proposed land treatment system is considered alternative technology. The overland flow system will use about one-half the electrical power and 80 percent of the labor required by a conventional extended aeration system.

As alternative technology, the entire treatment system qualifies for 85 percent grant funding. The grant will cover all Step 2 work and Step 3 construction, including land costs.

Impacts of the Project

The impacts of the project are decidedly beneficial, particulary since the local surface water quality will be improved and poorly functioning septic tanks will be eliminated. The current building restrictions in the area will be lifted, allowing development to resume. Dedicating the plant site to long-term use for a land treatment project is consistent with the agricultural character of the area. The user costs are lower with the overland flow alternative than with the mechanical treatment plant since the local share of the capital cost is lower and the O&M costs are reduced.

FACILITY PLANNING EFFORT

The facility planning for this project began in 1974. After the first alternative analysis was complete and the extended aeration project was approved for implementation, the City requested that the consultant reassess the possible treatment alternatives. In light of the 1977 legislation approving additional funding for innovative and alternative projects, land treatment was considered a possible alternative to the previously selected extended aeration system.

Project Alternatives

Two project alternatives were compared in the 1978 addendum to the facilities plan for Cleveland. Previous efforts had included detailed analyses of a variety of treatment systems, therefore only one mechanical method was used for comparison. Land treatment using overland flow also was considered and found to be most suitable for the local conditions.

Selection Procedure

The alternative analysis involved a comprehensive cost-effectiveness evaluation of the two alternatives. Other considerations such as environmental impacts, reliability, operability, energy utilization, labor requirements, implementation, feasibility, and public acceptability were also evaluated.

The City showed a strong preference for land treatment. Their feelings were reinforced by the potential savings in power, labor, and operating costs of the land treatment system. As a result, overland flow was selected as the most overall cost-effective treatment method. Detailed studies then were initiated to select the exact site for the proposed facilities.

Qualification of the I/A Project

This project is considered alternative technology according to the definition outlined in the Clean Water Act of 1977. The project meets the cost criteria by being within 115 percent of the cost of the most cost-effective conventional project. All of the facilities proposed for Cleveland are considered necessary for the overland flow treatment system, therefore, the entire project is eligible for 85 percent federal grant funding.

JONESVILLE/JERUSALEM, MARYLAND

This project is designed to relieve major waste disposal deficiencies in the communities of Jonesville and Jerusalem, Maryland. The proposed sewerage system represents a commitment on the part of Montgomery County and the Washington Suburban Sanitary Commission (WSSC) to provide relief to long ignored rural areas with substantial health and environmental problems. The approach was to provide assistance at a reasonable cost through the use of technologies that do not contribute to unwanted growth.

PROJECT DESCRIPTION

The proposed facilities include the use of storage grinder pumps and a pressurized sewer collection system. Wastewater treatment will be provided using an innovative batch process activated sludge system followed by land application. Land application will be through a flood irrigation technique in which treated effluent will be applied to confined, bermed cells at rates comparable to spray irrigation with the maximum weekly hydraulic loading not to exceed 2 in/ac. Buffer areas and monitoring wells also will be included. The average flow to be treated will be less than 23,000 gpd. The irrigation treatment/disposal area will total about 3 ac with additional reserve area.

Innovative and Alternative Technology

The entire treatment works qualifies for innovative and alternative funding including storage grinder pumps, pressure sewers, batch process activated sludge system and land application system.

Impacts of the Project

There are several social, economic and environmental impacts associated with the proposed technology for the project:

- Social
  - The County will be able to provide sewer service to two small rural communities which probably could not be done economically any other way.
  - Both communities are low-income, and consist predominantly of minorities, descendants of a group of related families who originally purchased their land in the 1870's. Neither community has been able to retain its young people because poor soil conditions preclude the approval of septic systems which are needed to rehabilitate existing housing or to construct new housing. The proposed treatment facilities will provide a sewer service which will allow these household members to return to their communities. Because of the lack of alternative septic systems, there have been no new homes built in the communities in the past seven years.

- Economic

  - With younger members of the existing households being permitted to return to their community; the entire community should benefit from an economic standpoint (younger work force, new home construction, etc.).

  - The proposed facilities provide an affordable solution to a wastewater problem which was previously unsolved.

  - Because of the extra 10 percent funding through the I/A program, the local share of project costs was reduced by 70 percent.

- Environmental

  - There will be no effluent discharge because the treated effluent will be applied to the land.

  - The facilities will solve a significant health problem in the two communities by eliminating failing septic tanks, pit privies, and contaminated wells.

  - The facilities will be constructed and operated by specially trained personnel from WSSC, thereby minimizing plant failures resulting from poorly trained operators.

In a more general sense, many rural communities similar to Jonesville and Jerusalem have been identified as having significant environmental and health problems. These communities, well beyond the reach of traditional public sewerage systems, stand to gain much if the Jonesville/Jerusalem project is successful. The engineering concepts of the project are noted for their simplicity in construction and operations, and the system may serve as a model for future small, rural community sewerage systems.

If the system fails, the communities would remain the same size and continue to experience problems associated with aging households and young family members leaving the community. Also, WSSC would have to continue working with the community and eventually solve the wastewater treatment and disposal problem.

FACILITIES PLANNING EFFORT

The Jonesville/Jerusalem project had already qualified for 75 percent Step 2 grant funding before the facilities plan was complete. As the engineers became involved with the design, they noted the possibility of obtaining additional funding under the I/A program. Consequently, a grant amendment for the extra 10 percent was made after the 75 percent grant had been awarded. It took approximately one year to retrofit the HUD documents for the project to fit the EPA criteria, since there was considerable time needed for decision-making by EPA and FHA. A considerable amount of time also was spent on site selection and on answering questions about pressure sewers.

Project Alternatives

The proposed treatment techniques for the Jonesville/Jerusalem project were evaluated as early as 1975, well before the I/A Program was conceived. Several alternative on-site systems had been considered and evaluated, including thermal and chemical toilets and evapotranspiration systems. These systems were rejected primarily due to their unreliability and inability to solve grey-water problems.

At the time a batch process activated sludge treatment system was selected, effluent criteria for pretreatment were 30 mg/L BOD_5 and 30 mg/L suspended solids. It was felt that a lagoon system would not meet these criteria consistently. Also, because of the small anticipated daily flows there would be a freezing problem in winter, and algae would be a problem during warm weather. The batch activated sludge system was compact, out-of-sight, simple, and provided better control over treatment operations.

Extended aeration plus tertiary treatment and nutrient removal for surface discharge also was evaluated, but proved to be uneconomical.

A conventional gravity collection system with pumping to nearby treatment facilities was considered in place of the proposed pressure sewer system. Use of gravity sewers, however, was neither feasible nor cost-effective based on the following:

- Long frontage between dwellings,
- Topography does not lend itself to economic accommodation of all users without extensive pumping, and
- Gravity sewer placement would cause greater disruption during construction.

Selection Procedure

The innovative and alternative technologies for Jonesville/Jerusalem were selected prior to the initiation of the I/A program. The choice of available treatment systems for the two communities was very limited due to several conditions:

- The communities are composed of predominantly low-income families who could not afford a sophisticated, expensive solution to their wastewater problem.

- Both communities are small, rural, and located too far from suitable existing treatment facilities to cost-effectively build a pipeline to a major treatment plant.

- Several on-site systems including chemical and thermal toilets had been tried previously by the County and were found to be inadequate.

As a result, the proposed technologies appeared to show the greatest potential for handling the problem in a simple and cost-effective manner. In addition, the Jonesville/Jerusalem project was being designed as a demonstration project for other rural communities in the County with similar wastewater problems.

Qualification of the I/A Project

The batch activated sludge system to be used at Jonesville/Jerusalem qualifies as innovative under the criteria of increased environmental benefit and most cost-effective alternative. Both the land treatment and pressure sewer systems qualify for funding as alternative technologies for small rural communities.

AUSTIN, TEXAS

The City of Austin currently is served by three wastewater treatment plants: the Walnut Creek Plant, the Govalle Plant, and the Williamson Creek Plant. Present plans call for three plants to continue to serve the City with a new 18 mgd activated sludge plant nearing completion at the Walnut Creek site and a new activated sludge plant proposed on Williamson Creek.

Several alternative means of treating wastewater from the City of Austin were considered and evaluated including the construction of a regional treatment plant to handle all wastewater from the City and abandonment of the three existing facilities. However, several studies concluded that it would be more economical to continue to operate three separate facilities and upgrade the Govalle Plant than it would be to abandon the plant and convey the wastewater to a new regional plant.

Original portions of the Govalle Plant were constructed about 40 years ago. The existing facilities provide approximately 90 percent removal of BOD and SS, and the plant effluent generally meets regulatory agency criteria. The effluent is chlorinated and discharged to the Colorado River.

There are no primary clarifiers at the current Govalle Plant. Excess activated sludge is partially aerobically digested in two converted secondary anaerobic digesters. The partially digested sludge is then pumped from the Govalle Plant to the Hornsby Bend sludge lagoons where it is mixed with river water and treated further in the lagoons. Most solids in the sludge settle out and are retained in the lagoons, while liquid from the lagoons evaporates or is treated in a separate lagoon system containing water hyacinths.

PROJECT DESCRIPTION

The proposed project involves upgrading the existing Govalle Wastewater Treatment Plant in order to improve process control, improve process reliability, replace worn-out equipment, and aesthetically improve the plant site. Since the project involves upgrading existing facilities, the treatment processes were essentially fixed and the evaluation of project feasibility did not involve a comparison of alternate treatment processes.

The proposed project includes the conversion of two existing, but currently unused primary anaerobic digesters to aerobic digesters and the installation of a supernatant return line from the digesters to the head of the plant. Conversion of the two existing anaerobic digesters to aerobic digesters will enable more complete sludge stabilization to be attained. Construction of the supernatant return line will allow the sludge to be settled following digestion and will reduce the volume of sludge to be pumped to Hornsby Bend.

The City of Austin intends to provide additional aerobic digester capacity at the Hornsby Bend site so that sludge from both the Govalle Plant and the Walnut Creek Plant (that is currently under construction) can be digested at Hornsby Bend. The City also is evaluating the feasibility of utilizing land disposal of

the aerobically digested sludge at the Hornsby Bend site; pilot studies involving blending of wet sludge into the ground are proposed. It will be some time, however, before an actual land disposal system is implemented.

Along with other modifications, the project also involves improvements to the existing water hyacinth ponds at Hornsby Bend. Because of prolific algae growth in the sludge ponds, water from the ponds exceeds the permits to discharge to the Colorado River. As a result, a separate 5-ac pond containing water hyacinths is used to remove algae and other suspended particles and dissolved impurities from the sludge ponds. For nine months of the year, the hyacinths produce an effluent meeting the permit parameter, but during the winter months, problems arise when the hyacinths freeze. Consequently, a greenhouse cover to promote year-round growth of the hyacinths is planned as part of the proposed project improvements.

Innovative and Alternative Technology

Three separate portions of the treatment works will utilize innovative or alternative treatment techniques.

After digestion, waste sludge will be recycled by returning it to the land. Windrow composting and injection into the soil are two recycling methods under consideration at this time. Digestion of waste activated sludge by earthworms to make compost is planned as a pilot study and would be considered innovative technology since the methods are not fully proven. It is understood that EPA is determining the earthworm capability at the City of Lufkin. This study will be observed and copied in Austin, if it is found applicable and practicable.

The construction of anaerobic digesters to treat waste sludge and the use of 400 hp engine generators for conversion of digester gas to electricity is also planned. This energy recovery and utilization as a fuel source is considered alternative technology.

A greenhouse cover to provide year round growth of the water hyacinths is planned as innovative technology. Algae from the sludge ponds causes the suspended solids to exceed the discharge permit parameters, but the City has found that water hyacinths will remove the impurities and particulate matter to levels below 20 mg/L, well within permit limits. Problems arise when the hyacinths freeze, so a cover is planned. Hyacinth growth is greatest at 20°C or higher and supplemental heat from digesting or composting excess hyacinths may be possible. Excess hyacinths readily decompose into compost which also may be used.

Impacts of the Project

Impacts associated with the use of water hyacinths at the Austin treatment facilities include:

- Energy savings
- Possible value from composting harvested hyacinths

- Capability of meeting discharge requirements year-round rather than only 9 out of 12 months each year
- Cost-effectiveness (almost no cost)
- Reliability and ease of O&M
- Potential for widespread application of the process in numerous small towns
- Waste product (sludge) is treated in an aesthetically pleasing atmosphere since the ponds are covered by a dense growth of lush green hyacinth plants which also produce beautiful white flowers.

The benefits of using anaerobic digesters include gas recovery and utilization, cost-effectiveness, and more reliability since the recovered gas can be used as an emergency power source.

Benefits of the proposed earthworm sludge digestion pilot study include the production of real operating data and possible future design criteria for a previously unproven technology. Also, it may be possible to harvest the worms and sell them as a fishbait or use them as a protein source in animal food.

FACILITY PLANNING EFFORT

The facilities planning effort was not seriously affected by the use of innovative and alternative technology in this project. The first facilities plan was prepared in 1977 and has been changed or updated on several occasions. In August 1979, the City applied for Step 2 grant funding at 85 percent to include their I/A technology. There was little extra effort in facilities planning; the City merely applied for 85 percent rather than the normal 75 percent grant. There have been no delays as a result of the I/A components of this project; on the contrary, the use of I/A technology may even expedite project approval and funding.

Project Alternatives

Since the project involves upgrading existing facilities, the treatment processes were essentially fixed and the evaluation did not involve a comparison of alternate treatment processes. Instead, the evaluation process included the possibility of abandoning the plant rather than upgrading it.

Selection Procedure

The City had already been involved with the use of anaerobic digestion and had several years of experience with hyacinths. The elements of risk associated with these technologies did not affect the selection procedure; the City would have selected these processes even without the I/A program or its funding.

The digestion of waste activated sludge by earthworms to make compost was selected as a pilot study at the recommendation of the State. The City would not have selected this process without the I/A program.

Qualification of the I/A Project

The proposed earthworm digestion process would be given innovative project priority since it is not a fully proven treatment method. This portion of the project may qualify through discretionary approval by the Regional Administrator.

Anaerobic digestion with energy recovery qualifies as alternative technology by definition.

The water hyacinth project qualifies as innovative technology since it is not fully proven on a large scale. No detailed cost-effective analysis was performed in comparing this innovative technology to conventional treatment.

MIRANDA, CALIFORNIA

Miranda Community Services District (CSD) is a community of 300 people located on a terrace approximately 100 ft above the South Fork Eel River in Humboldt County, California. The District contains a regional high school complex in addition to the residences. As a result of the school, the day population increases by about 500. The community has limited commercial use, but is a popular tourist area, particularly during the summer months.

The health hazards associated with failing septic tank/leachfield systems have been documented by the County Health Department, even during the dry winters recently experienced in California. The system at the high school has failed completely and is threatening to contaminate local surface water supplies. There is only one section of the CSD that has not experienced septic tank failures, apparently due to a difference in soil and groundwater characteristics.

PROJECT DESCRIPTION

The proposed project for Miranda CSD is the construction of a small diameter gravity collection system and waste treatment using a recirculating sand filter system with ultimate waste disposal in percolation ponds. Waste collected by the sewer system originates from individual septic tanks which partially treat the wastewater prior to collection. Originally, a community leachfield was proposed, however, soils at the selected site were inadequate and another site suitable for this disposal method could not be located.

An extensive survey will be made to determine the number of the existing septic tanks that can be upgraded and made watertight and the number of systems that will need to be replaced. All of the septic tanks will require periodic pumping and appropriate disposal of the septage.

The recirculating sand filter consists of 3 ft of sand overlaying 10 ft of gravel with an underdrain. Routine maintenance includes weekly raking of the surface to minimize plugging and to promote reaeration, and periodic replacement of the top layer of sand. The waste is recirculated an average of five times before disposal.

Innovative and Alternative Technology

The recirculating sand filter has been classified as innovative technology and the collection system as alternative technology. The project will be given funding priority; however, no I/A money will be given until the design (Step 2) has been completed. If sufficient funds are available, the extra 10 percent grant funds for Step 2 and the total grant funds for construction (Step 3) will be awarded.

Impacts of The Project

Impacts of the proposed project include:

- Elimination of health hazards associated with failing septic tanks
- Major effort in community participation
- Elimination of surface discharge which enhances tourism in the Eel River area
- System is economical, has minimal land requirements, and produces minimal odors.

FACILITY PLANNING EFFORT

The draft facility plan for Miranda CSD was completed in October 1978. Therefore, the possibility of I/A grant funds was not considered in the evaluation of alternatives. The facility plan was finalized in July 1979, after soils investigations showed that the originally proposed leachfield was not an acceptable disposal method. The plan amendment addressed the possibility of receiving an extra 10 percent grant funding.

Project Alternatives

The study area was divided into three subareas according to the terrain and soil conditions in each area. Subareas A and B were subject to septic tank failures while Subarea C contained a number of individual systems which functioned satisfactorily.

The alternatives for Subareas A and B included:

- Conventional gravity collection system, aerated facultative lagoons, and percolation pond disposal
- Small diameter gravity collection system (for septic tank effluent), aerated facultative lagoons, and percolation pond disposal
- Small diameter gravity collection system for septic tank effluent and community leachfield.

Reassessment of alternatives later resulted in the recirculating sand filter system being considered in addition to the first two alternatives.

The alternatives for Subarea C included:

- Public management program for individual on-site systems (routine maintenance to insure long-term operation)
- Replacement of failing septic tank/leachfield systems and establishment of maintenance program
- No project.

Selection Procedure

The selection procedure was based on a weighted cost-effectiveness matrix. Considerations included monetary costs, environmental and social impacts, flexibility and reliability, public acceptability and other minor factors. The alternatives for Subareas A and B and for Subarea C were evaluated independently. In the second analysis of alternatives for Subareas A and B, monetary factors favored the recirculating sand filter system to a high degree and there were no overwhelming environmental or social considerations precluding implementation of this alternative. As a result, the recirculating sand filter system was selected for these subareas.

Qualification of the I/A Project

The proposed collection system for Miranda has been given an alternative project priority and the treatment system has been given an innovative priority. The septic tanks and gravity sewers are considered part of an individual treatment system for a small community and have been assigned a priority 2. The recirculating sand filters are considered innovative based on cost savings and reduced environmental and social impacts.

The collection system also has been designated a demonstration project by the State. Operation and maintenance costs for the first two years are to be paid by the State in return for monitoring and critical analysis of the system operation. Annual reports will document the effectiveness of design, equipment operation, and costs.

BAY PARK
NASSAU COUNTY, NEW YORK

The 60 mgd Bay Park Sewage Treatment Plant in Nassau County, New York currently uses conventional activated sludge for secondary treatment. Because the plant is overloaded, the Nassau County Department of Public Works had contracted with a consulting engineer to prepare a facilities plan for upgrading and expanding existing facilities. The plan includes a 10 mgd addition to the existing plant capacity.

PROJECT DESCRIPTION

The proposed project for Nassau County includes upgrading the existing 60 mgd activated sludge facilities and using an innovative fluidized bed treatment system as the secondary treatment process for the 10 mgd expansion of the plant. Anaerobic digesters with methane gas recovery and composting facilities also are planned. The Nassau County project includes other phases but this case study was developed for the fluidized bed furnace system.

Innovative Technology

Nassau County has supported research in fluidized bed technology since 1972. Although research was being conducted in several areas including carbonaceous BOD removal, nitrification, and denitrification, the main thrust had been in denitrification.

The basic concept of the process consists of passing wastewater up through a bed of sand at a velocity sufficient to impart motion to or "fluidize" the sand. Just as with a trickling filter, a stable population of biological organisms eventually coats each grain of sand. The key to the success of the process is the enormous surface area provided by the sand for microbial growth. The result is an extemely high-rate system which combines the best features of activated sludge and trickling filtration into one process. Like trickling filtration, the biological mass is fixed in the system, giving the process greater stability in handling shock and toxic loadings, but unlike trickling filtration, there is a minimal sloughing of the growth. Therefore, elimination of secondary clarifiers is possible. As with suspended growth processes, extremely high concentrations of biomass can be maintained within the system, but in the fluidized bed process, the concentration of MLVSS has been measured at between 8,000 and 40,000 mg/L, an order of magnitude higher than suspended growth. Because of the high rate nature of the fluidized bed process, pure oxygen is used in the aerobic system for BOD removal and nitrification, with the efficiency of oxygen utilization over 90 percent.

Impacts of the Project

Impacts of the proposed innovative technology include the following:

- Cost Savings - Proposed fluidized bed system was the most cost-effective alternative evaluated.

- Innovative Technology - Including the guarantees of a new system if the proposed facilities do not operate to specification.

- Overall County Experience - The proposed technology is considered a viable process in which the County has supported research for a number of years. If the system is successful, it could replace activated sludge in future designs.

- Reduced Research Time and Money at Cedar Creek - Originally, the County's Cedar Creek treatment facility was being planned to include a 1 mgd pilot study using a carbonaceous fluidized bed. As a result of the Bay Park innovative monies, a cost reduction in facilities planning for Cedar Creek was allowed, with a corresponding savings in County funding.

- Less land area required for same treatment capacity.

- Better operational control with activated sludge.

- Net energy savings.

- Extremely high concentrations of biomass can be maintained within the system (between 8,000 and 40,000 mg/L MLVSS).

- If the process is a success, the Cedar Creek Plant expansion could incorporate fluidized bed treatment rather than AWT facilities.

- If the technology is a success, there is a chance that areas presently closed to fishing in parts of New York could be opened as a result of the Bay Park Facilities.

FACILITY PLANNING EFFORT

The original facilities plan for the Bay Park project was published in May 1976. At the earliest, it was estimated that design could begin in April 1979 if the activated sludge approach were taken. In December 1978, the New York Department of Environmental Conservation (NYSDEC) approved the activated sludge process described in the facilities plan. Around the same time, the County had developed a proposal for converting a 10 ft diameter sand filter at Bay Park to a carbonaceous BOD reactor. In January 1979, review of the Step 2 grant application for the activated sludge facilities was stopped because the County was re-evaluating treatment alternatives including the fluidized bed. With the provisions of the I/A program, the County began to seriously pursue the idea of incorporating the fluidized bed system into the 10 mgd expansion of Bay Park if the facilities qualified for I/A funding. In February 1979, EPA informed the County of the necessary documentation to be furnished to the EPA and NYSDEC regarding the selection of the secondary treatment process for the 10 mgd expansion. A cost-effective analysis and basic design data report on the fluidized bed system were prepared and submitted in March 1979.

Project Alternatives

The proposed fluidized bed treatment was evaluated along with several variations of air and pure oxygen activated sludge. The cost-effective analysis and energy conservation analysis for the fluidized bed were compared with upgrading and expanding the plant using conventional activated sludge for secondary treatment. The secondary treatment facilities using the innovative fluidized bed system include:

- Contact Vessel
- U-Tube
- Fluidized Bed Treatment Equipment
- Oxygen Generator
- Pump Building
- Final Clarifier Tanks
- (Waste Activated Sludge) WAS Pumps

Secondary facilities using conventional activated sludge include:

- Aeration Tanks
- Blowers and Building
- Final Clarifiers
- RAS Pumps and Building
- Sludge Pumps

Selection Procedure

The selection of the proposed fluidized bed treatment system was based primarily on cost and energy savings. The proposed system was considered more advantageous in terms of space requirements since the site is land-locked and space is limited.

The availability of I/A funding also played a major role in the selection fluidized bed technology. The County has been financing research in the area since 1972 and realized the financial benefits of stepping up pilot work and proposing the innovative technique for use in the 10 mgd expansion of Bay Park. If innovative monies had not been granted for Bay Park, Nassau County would have continued with their original activated sludge proposal as the secondary treatment process for the plant.

Qualification of the I/A Project

Originally, the cost-effective analysis and the energy savings comparison were performed based on upgrading and expanding the treatment facilities. The documentation confirmed the fluidized bed system as qualifying for innovative monies under the cost-effectiveness and energy conservation criteria. In June 1979, the I/A manual was available so the Bay Park plan was then evaluated according to the guidelines in the manual. This evaluation resulted in a substantial number of questions regarding the qualification of the project, and required the County and its consultant to revise its comparison of alternatives. Specifically, the cost-effective analysis was to include not only upgrading and expansion of the facilities, but also ocean discharge. When the cost of a 2.5 mile ocean

outfall ($56 million) was included, the proposed project did not result in a 15 percent life cycle cost savings and, therefore, did not qualify for innovative funding. The project also did not qualify under the energy savings option (fluidized bed treatment with ocean outfall represented only an 8.6 percent energy savings rather than the required 20 percent).

The project was finally granted innovative status by discretionary approval of the regional administrator, even though the qualifying criteria were not strictly met.

CONCLUSIONS

Conclusions determined while developing these case studies are summarized below:

- The perceived degree of risk has not been that great with any of the projects investigated. More risky projects involved fairly reliable backup processes or would not lead to disastrous social or environmental effect should they fail.

- The engineers viewed any risks as being greater than the owners or State personnel did.

- Most owners had complete faith in their consultants. Most engineers felt strong obligations to their clients to maximize grant funding for their projects, even if they involved risk.

- In many cases, the owner initiated the I/A funding procurement, either directly or indirectly.

- In all cases, the initial facility planning efforts were begun prior to the passage of the Clean Water Act of 1977, therefore some degree of "backtracking" was necessary to get I/A funding approved.

- Delays encountered in getting project approval varied. In many cases there was some question as to whether a project was innovative or alternative.

- In general, the consulting engineer needs more incentive to actively use innovative technology since his reputation is at stake if a project fails.

- The 100 percent replacement provision was viewed with mixed reactions. Some participants had ultimate faith in the warrantee, while others looked on it with skepticism.

- Most owners and their consultants would be willing to implement an innovative or alternative project again, particularly if it meant reduced O&M costs or a more reliable or less complex treatment system.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1981 341-082/249